A Historical perspective on science and its 'others'

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Abstract:

Reflecting on the debate concerning the value to historians of the category "popular science", this paper argues that the model of legitimate science that is currently emerging, invites us to consider how the notions of science and the public have been mutually configured and reconfigured over time. First, it points to the tremendous impact of technosciences on the public sphere. The recent shift from the deficit model to the participatory model has profoundly changed the values underlying science communication. Whereas previously it was performed in the name of science, it is now performed in the name of democracy. This political turn suggests that we should consider symmetrically not only how science and its public face are socially constructed but also how the notion of a lay public has been constructed by scientific practices. Finally I suggest that historical studies should focus on the mechanisms of demarcation and discrimination between science and rival forms of knowledge.

Over the past twenty years, the use of the category "science popularization" for historical studies has become a matter of debate. Cooter and Pumfrey argued that the notion was no longer relevant because it implies a demarcation between the production of science and its consumption, thus illegitimately separating history of science from the history of science popularization.[1] In the conclusion of his historiographical reflections (2004), Jim Secord argued that science popularization should no longer be a separate focus of study, and suggested using the paradigm of communication as the most relevant to deal with the history of science and its popularization.[2] More recently, Jonathan Topham also argued that studies of the two intertwined histories should be reunited, and that science should be considered as a form of communicative action.[3]

Generally, two decades of intense scholarship in the history of science popularization have led to the recognition that science popularization is not a neutral entity.[4] The term science

[1] Roger Cooter and Stephen Pumfrey, "Separate Spheres and Public Places: Reflections on the History of Science Popularization and Science in Popular Culture", *History of Science*, 32 (1994): 237–67.
[2] James A. Secord, "Knowledge in Transit", *Isis*, 95 (2004): 654–72.
[3] Jonathan R. Topham, "Rethinking the history of science popularization/popular science", in F. Papanelopoulou, A. Nieto-Galàn, E. Perdiguero, eds, *Popularising Science and Technology in the European Periphery, 1800-2000*, Aldershot, Ashgate, 2008.
[4] Baudouin Jurdant, "Vulgarisation scientifique et idéologie", *Communications*, 14 (1969):150–161. P. Roqueplo, *Le partage du savoir, science, culture et vulgarisation*, Paris, Seuil, 1974. Sheets-Pyenson S. "Popular science periodicals in Paris and London: the emergence of a low scientific culture 1820-1875", *Annals of Science*, 42 (1985): 549-572. Stephen Hilgartner, "The dominant view of popularization: Conceptual problems, political uses", *Social Studies of Science*, 20 (1990): 519–39, Marcel La Follette, *Making Science Our Own. Public Images of Science 1910-1955*,

popularization itself is a recent invention when compared to the *longue durée* of history of science. The term was first coined in the nineteenth century, when science became a professional activity.[5] Because the term was invented to describe science communication in specific circumstances, it may be seen as anachronistic to use it to describe a varied assortment of science communication. Science popularization is just one among many configurations of the relations between science and society at large. Moreover, the emergence of this configuration in the nineteenth century was a long and contingent process. In many places, popularization had to compete with a variety of alternative science practices, sometimes labelled as "popular science". In most cases, the term "science popularization" was used to reflect the hegemony of the professional practice of science, and by association, to legitimate the authority of experts.

I therefore fully sympathize with Topham's urge for reconceptualizing the issue of popular science. Yet, is communication the most adequate framework? Scientific research is not split into two neat phases consisting of the production of knowledge and its communication. There is a continuum between the two, and to an extent, the material means of communication shape the message.[6] As Topham argues, popular writings have been used in many cases to advance professional research, as they proved an efficient tool to prompt paradigm changes.[7] Still, recognizing that the process of producing scientific results and the process of communicating them are indistinguishable, does not require that science is fully understood as a communicative action. Regardless of the heuristic power of the actor/network model, it does not necessarily lead to the identification of science as a form of communication.[8] In my view, it rather invites historians to try to grasp what is specific to science among other forms of communication. Considering science as a form of communication had the merit of shifting the focus of attention from the source of scientific knowledge (scientists and laboratories) to its audiences (students, and consumers of popular books). Another immense merit of this approach was to focus the historians' attention on the material

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Chicago, London, The University of Chicago Press, 1990. Bruce Lewenstein ed., *When Science Meets the Public*, Washington DC, American Association for the Advancement of Science, 1992. Anne Secord, "Science in the Pub: Artisan botanists in early nineteenth-century Lancashire", *History of Science*, 32 (1994): 269-315. Bernadette Bensaude-Vincent, Anne Rasmussen eds., *La science populaire dans la presse et l'édition XIXe et XXe siècles*, Paris, CNRS éditions, 1997. Paola Govoni, *Un pubblico per la scienza. La divulgazione scientifica nell'Italia in formazione*, Rome, Carocci, 2002.

[5] Bernadette Bensaude-Vincent, "La science populaire: Ancêtre ou rivale de la vulgarisation?", *Protée: Théorie et pratiques sémiotiques*, 16 (1988): 85–91.

[6] Terry Shinn, Richard Whitley, *Expository Science: Forms and Functions of Popularization*, Dordrecht-Boston-Lancaster, D. Reidel, 1985. Steve Shapin "Science and the public", in R.C. Olby et al. (eds.), *Companion to the History of Modern Science*, London, Routledge, 1990, pp. 990-1007. Jan Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760–1820*, Cambridge, Cambridge Univ. Press, 1982.

[7] Jonathan R. Topham, "Rethinking the history of science popularization/popular science", op. cit. supra, An additional example of this strategy in the history of physical sciences is Jean Perrin's popular publication *Les atomes* (1913), a demonstration of molecular reality meant to convince reluctant physicists and chemists of the existence of atoms.

[8] See in particular Bruno Latour, *Science in Action*, Milton Keynes, Open University Press, 1987, p. 62.

vehicles of science communication such as journals, books, conferences, and museums.[9] Still, whilst the histories of the press, books, movies or teaching undoubtedly shed new lights on the history of science, they should not make us forget that science is more than the production and communication of factual data. Science is a normative activity, which generates universal standards, and strong values that in turn shape society at large. We are thus faced with a tension between the need to provide a larger conceptual framework to pursue historical studies of science, and the ambition to focus on what is unique in science communication and what is specific to each historical period, and each science (the concepts used for popular astronomy do not necessarily work to communicate biotechnology).

In this essay I advocate an approach to the history of science and popular science based on two methodological principles: reflexivity and symmetry. Why do we feel uncomfortable with the category of popular science? This is the first question to raise if we are to adopt a reflective attitude. The first section therefore examines the model of legitimate science which is emerging today, because it determines the way science is spread within society at large. The second section emphasizes the recent shift from the traditional practice of science communication *in the name of science* to new practices of interactions *in the name of democracy*. This political turn suggests that we should consider symmetrically not only how science and its public face are socially constructed but also how the notion of a lay public has been constructed by scientific practices. Finally I suggest that historical studies should focus on how the notions of science and the public were mutually configured and reconfigured through the *longue durée*.

From the deficit model to the participatory model

Reflexivity is a major methodological imperative for all historians, and we have to be aware that history is always written according to the present time. As Lucien Febvre, the founder of the *École des Annales*, put it in his vivid personal style: "Man does not remember the past; rather he always reconstructs it. Isolated man [is] an abstraction. Man in [a] group [is] a reality. He does not keep the past in his memory, as the Northern ices keep millenary mammoths frozen. He starts from the present and it is through the present that he knows the past."[10] Lack of awareness that present

[9] See for instance James A. Secord, *Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation*, Chicago London, The University of Chicago Press, 2000. Jonathan R. Topham, "Scientific publishing and the reading of science in nineteenth-century Britain: A historiographical survey and guide to sources", *Studies in History and Philosophy of Science*, 31(2000):559-612.

[10] Lucien Febvre, *Combats pour l'histoire* [1952], Paris, Librairie Armand Colin, 1992, p. 14. "L'homme ne se souvient pas du passé; il le reconstruit toujours. L'homme isolé, cette abstraction; L'homme en groupe, cette réalité. Il

norms and values were being projected onto descriptions of the past even led, Febvre declared, to a "deification of the present through the past".[11] This said, historians can use the present as a filter to shed new lights on the past, thus generating more complex, and richer perspectives on our history. Cooter and Pumfrey rightly noted that science popularization was a reflection of the model of authorized science that dominated in the twentieth century. The new model of legitimate science that tends to prevail in our societies – often named "technoscience" – leads to the *de facto* reconceptualization of the issue of popularization.

The contrast between the former model and the currently emerging model is striking. Based on the numerous sociological and historical studies of practices in science popularization, here is a brief summary of the former model through its three basic assumptions. i) There is an increasing gap between scientists and the public, due to the unavoidable specialization of scientific investigation, and the formalization of scientific discourses.[12] Contemporary actors and witnesses have often related the perceived radical gap between the scientists' worldview and common sense, to the emergence of a new physics - relativity theory and quantum mechanics. ii) The alleged gulf between the scientific elite and the lay public calls for mediators, or popularizers, whose task is to bridge the everexpanding gap in order to gain public support for scientific research. In their attempt to "translate" the language of experts for lay people, mediators have tended to consider the public as a passive audience, made up of consumers of science and technology (diffusionist model). iii) Popularization was a one-way process, speaking "*in the name of science*" without paying attention to public concerns.[13] The public was seen as a mere recipient of scientific advances, characterized by its lack of knowledge (deficit model). It was also assumed that increasing the public understanding of science would automatically generate more favorable attitudes towards science. In reality, popularization has contributed to isolating scientists from the rest of the world, and to turning science into a sacred all-powerful deity thus increasing, rather than decreasing, the alleged gap.

Over the past two decades, technosciences such as information technology, biotechnology, and nanotechnology have developed in parallel with the urge to refocus science on social concerns. "Dialogue" and "public engagement in science" have become fashionable watchwords. Meanwhile, a spectrum of procedures designed to involve the public, from opinion polls to public hearings,

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ne conserve pas le passé dans sa mémoire, comme les glaces du Nord conservent frigorifiés les mammouths millénaires. Il part du présent et c'est à travers lui, toujours qu'il connaît."

[11] Ibid. p. 8.

[12] Bernadette Bensaude-Vincent, "A genealogy of the increasing gap between science and the public", *Public Understanding of Science*, 10 (2001):99–113.

[13] Bernadette Bensaude-Vincent "In the name of science" in John Krige, D. Pestre eds, *Science in the Twentieth Century*, Amsterdam, Harwood Publishers, 1997, pp. 319-338.

consensus conferences, citizen juries, focus groups, and hybrid forums, have undoubtedly changed both scientific practices and the public itself.[14] On the one hand the previously widely held view that the scientific elite is homogeneous and speaks with a single voice has been seriously challenged. Instead, science is increasingly viewed as an archipelago of scattered islands populated by experts in increasingly narrow fields. In this landscape, experts do not necessarily hold the same views on the scientific issues that the public is concerned with. As scientific controversies between experts have become more and more commonplace, on issues such as GM crops and climate change, a plurality of expert opinions has had to be recognized.[15] Recent controversies have revealed the social dimension of technoscientific issues, and new actors, including policy makers, as well as representatives of the private sector, user groups, consumer associations, environmental activists, trade unions, and NGOs have been called to the stage front. On the other hand, in this new context of participatory science, the public is no longer viewed as a passive audience. Even the use of the generic term "public", often used to describe an un-differentiated mass of passive consumers has been superseded by the use of the political term "citizens", which suggests a variety of motivated individuals or informed groups, acting as responsible actors and members of civil society.

The changing vocabulary suggests a shift from the practice of science communication *in the name of science* to new practices of interactions *in the name of democracy*. This political turn ascribes two distinct roles to citizens as assessors of technology or co-producers of knowledge. In the former case they are asked to give their opinions about research programs, or the impact of technoscientific innovations. When invited to participate upstream in the R&D phase, rather than downstream, when innovations enter the market, assessors may prompt decisions in science policy and impose new regulations. In the latter case, citizens are invited to cooperate in the construction of technoscientific knowledge.[16] For instance, the free and open source software movement contributes to the advancement of knowledge in information technology, thus reviving the ideal of the enlightened amateur. Citizens are mobilized, not only as individuals who volunteer to improve technology or to augment knowledge, but also on the basis of political activism. A number of NGOs, environmentalist movements, as well as patients and consumer associations have set up

[14] For a review of the emergence of this model see Massimiano Bucchi, Brian Trench, *Handbook of Public Communication of Science and Technology*, London, Routledge, 2008.
[15] See for instance Massimiano Bucchi, Federico Neresini, "Life Science, Governance and Public Participation: the New Dilemmas of Democracy" in *Modern Biology and Visions of Humanity*. Brentwood, Essex: Multi-science Publishing, 2004. p. 171-184
[16] See Callon, Michel "The Role of Lay People in the Production and Dissemination of Scientific Knowledge," *Science, Technology & Society* 4 (1999): 81–94. M. Callon, Pierre Lascoumes, Yannick Barthes, *Agir dans un mode incertain. Essai sur la démocratie technique*, Paris, Seuil, 2001.

their own laboratories and research facilities, thereby allowing them to produce their own independent expertise on specific issues such as medical research, radioactive contamination, or genetic adulteration.[17] Such experiences, where knowledge was co-produced by citizens and scientists have fuelled the growing demand to bring science and technology back into the public arena.

Knowledge co-productions also reflect a dramatic change in epistemic culture. Clearly the co-production of scientific knowledge by citizens and scientists could not be envisioned during, for example the golden age of nuclear physics, where knowledge was generated in confined laboratories, using high precision experiments and instruments. Co-production is made possible by the increasing prevalence of computers, and computer-based modelling, which has reoriented scientific investigation towards the collection of innumerable data rather than the search for universal laws of nature. The revival of the Baconian empiricist ideal of data collection, made possible by computer technology, converges with the growing political demand to re-align technoscientific decisions to democratic values, such as transparency and public good.

The political turn

It would be naïve to think that a couple of hybrid forums and citizen panels alone have the ability to quickly find solutions to the big technoscientific challenges of our time. It is indeed too early to evaluate their impact on technological advancement and society. Enthusiastic advocates of public participation have boldly announced the advent of a "technological democracy", characterized by the end of the age of experts, and the emergence of a distributed collective intelligence. Yet, such prophecy still seems unlikely to become a reality for some time, because i) public participation remains confined to a very limited set of technoscientific issues, ii) citizens' intervention in the process of decision making has been so far limited in its scope, iii) democratic debate is an open-ended process, which favors controversy rather than rapid decisions.

However these new forms of public involvement may gradually bring about dramatic changes in the practice of both science, and politics, provided that their philosophical implications are considered seriously. In particular, the assumption underlying participative experiences is that science constitutes just a fraction of the knowledge capital in a society. Another assumption is that

[17] An early example of co-production of knowledge was in AIDS research. Patients contributed to experimental investigation even conducting clinical trials on a specific drug after scientists had refused the procedure. Epstein, Steven, "The Construction of Lay Expertise: AIDS Activism and the Forging of Credibility in the Reform of Clinical Trials" *Science, Technology & Human Values* 20(1995): 408–37. Epstein, Steven (1996) *Impure Science: AIDS, Activism and the Politics of Knowledge*, Berkeley: University of California Press, 1996.

science has a tendency to develop independently of societal concerns, to ignore other sources of knowledge and therefore must be regulated by external powers. Both assumptions have a subversive potential which could dramatically affect the criteria currently used to evaluate science. Scientific achievements are currently evaluated according to the criteria of effectiveness and excellence, with an arsenal of "*dispositifs*" such as bibliometrics, benchmarking, and ranking lists. Those criteria responding to a technocratic vision of science as a key for success in a context of global competition for power may gradually be replaced by new criteria, such as the intensity of cooperation among different actors, as suggested by Massimiano Bucchi and Federico Neresini.[18]

In fact, as Bucchi and Neresini convincingly argue, the process of co-production concerns not only scientific knowledge but democratic society as well. "Democracy, like science, cannot be taken as given. Just as the latter is transformed by the entry of citizens into research laboratories, so the former is transformed when, for instance, scientists protest in public or propose a "compromise" on the public funding of stem cell research".[19] Democratic societies are being reshaped by their technological choices and they redefine their identity through their science policy. In the near future, the top priority may be the creation of research collectives rather than the production of new materials or new medicines. In this respect the open-endedness of public participation *dispositifs* should no longer be viewed as a major default. A new form of democracy is gradually emerging through such participatory experiences: no longer is it defined as a majority voting system with elected representatives of the people. Rather it tends to be redefined as a system of participation where each individual citizen or group of interests should be given a voice. They tend to be redefined as "stakeholders", partners of technoscientific ventures.

Symmetrically, new criteria may be taken into account for evaluating the advancement of knowledge. There are pressures from a number of sponsors of scientific research for changing the game rules. Scientific excellence could gradually include reflection and interaction with the public. Social and ethical issues are becoming normal and integral parts of the applications to scientific programs in the European Union. Concerning the evaluation of scientific performances, the diversity of options that are being invented and explored rather than the number of publications in top journals or the number of patents could become indicators of excellence. Similarly instead of prioritizing a single optimized solution in science policy and disqualifying alternative research pathways, the new emerging configuration could lead to pay attention to a variety of options and opinions and to consequently explore a wide spectrum of options. Right now this scenario sounds a

[18] Bucchi M., Neresini F., "Science and public participation" in Hackett E., Amsterdamska O., Lynch M. eds, *Handbook of Science and Technology Studies* – 3rd Edition, Cambridge, Mass: MIT Press, 2007. p. 449-473, on p. 464-65.

bit futuristic; however, it is not just utopian. A number of think-tanks, such as DEMOS in U.K, are working in this direction.[20] Sponsors of scientific research are also aiming at a co-production of technoscience and society. For instance, in 2004, the European Union issued a report on Research and Development in Converging Technologies – Biotechnology, Nanotechnology, Information Technology and Cognitive Science – which clearly responded to the US program on the same topic published in 2002.[21] According to its *rapporteur*, Alfred Nordmann, the European program for Converging Technologies was a testing ground for European identity in the aftermath of the failed attempt to construct a political entity by the vote of a European constitution.[22] In other terms technoscientific choices provide a grand experiment for building up a European democracy and reinforcing European values and ideals.

The new configuration of relations between scientific elites and lay people generated by contemporary technoscience reveals the political dimension of the issue of popularization. It does not mean that the interaction between science and politics is a distinctive feature of the technoscientific era. Rather I would suggest that it is an incentive for historians to investigate the role of science in the development of the Western notion of democracy. Strikingly the classic reference work by Jürgen Habermas, describing the emergence of the public sphere in the cafés and newspapers of the Enlightenment period overlooked the role of provincial and national academies and the "Republic of Letters".[23] Historians of science have thoroughly investigated the socio-construction of science. It is time now to examine the technoscientific construction of societies. To this end the space formerly occupied by science popularization is a good terrain of investigation.

The mutual construction of science and its public

How to reconceptualize the issue of science popularization? Given that the notions of "popularization" and related notions such as "lay public" or "science mediators" are historical

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[19] Ibid on p. 466.
[20] DEMOS, a "think tank for every day democracy" has issued a number of reports on technoscientific issues [www.demos.co.uk]. In particular see James Wilsdon, Rebecca Willis, See-through Science, London, Demos, 2004. James Wilsdon, Brian Wynne, Jack Stilgoe, *The Public Value of Science or How to Ensure that Science Really Matters*, London, Demos, 2005.
[21] EU HLEG (European Union High-Level Expert Group "Foresighting the New Technology Wave": (Rapporteur: A. Nordmann): *Converging Technologies - Shaping the Future of European Societies*. Brussels, 2004. Roco, M. and William Bainbridge eds., *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science*, NSF/DOC-sponsored report, Arlington., 2002 [http://www.wtec.org/ConvergingTechnologies/]
[22] Alfred Nordmann, "The European Experimentation" forthcoming in *Osiris*.
[23] Jürgen Habermas, *Strukturwandel der Öffenlichkeit: untersuchugen zu einer Kategorie der bürgelichen Gesells*, Neuwied, H. Luchterhand, 1962. Habermas later examined the role science and technology in society in *Technik un Wissenschat als Ideologie*, Frankfurt am Main, Surkhamp, 1969.

constructions rather than stable categories, a pluralistic historiography is called for that would not separate legitimate science from alternative popular knowledge. As O'Connor's paper suggests marginalized practices require more attention. Historical studies should tend to provide a better understanding of how the demarcation between legitimate science and non-legitimate knowledge has been generated and how it is endlessly renegotiated. Bearing in mind that science is a normative activity in competition with other forms of knowledge we should focus on the various processes of marginalization, exclusion and disqualification. As I argued elsewhere, from the outset of Western science in ancient Greece, a clear border has been drawn between science and common knowledge, between *epistemê* and *doxa*.[24] The demarcation line is not a by-product of scientific activity, it is rather a foundational gesture. The involvement or the exclusion of lay people is a key ingredient that shapes not only valid scientific methods but also the goals of scientific endeavors. In other terms, if we want to better understand the changing identities of science we have to take into account the changing configurations of its "others": the lay public, amateur practitioners, charlatans, pseudo-scientists, and such like. The history of science should no longer be isolated from the history of the public's attitude toward science. The public is not a passive spectator of scientific advances, it is *volens-nolens* the partner of scientific enterprise. Most historians of science do not even suspect that the notion of public has its own history, an intricate history, which intertwines political and commercial aspects, as well as cultural and scientific dimensions. We should consider the co-production of science and its "others" in the *longue durée*. Historical epistemology requires historical "doxology" (the historical study of opinions, and popular knowledge) as a counterpart.

Their complementarities may be instantiated in the case of alchemy. To make a long story short, let us remember that medieval alchemists who attempted to make gold in their laboratories and developed philosophical frameworks for interpreting their experiments were never integrated in the universities (which nevertheless included a number of liberal arts). Alchemical works were in conflict with one major claim of the dominant scholastic culture, namely the idea that art can only imitate nature.[25] Alchemical fire and recipes could not produce genuine gold, they only looked like gold. Following Avicenna's attack on alchemists they were condemned either as charlatans or as magicians. The ambient suspicion and hostile attitude of the dominant culture nevertheless contributed to shape alchemy and to advance knowledge. In response to their attacks alchemists

[24] Bernadette Bensaude-Vincent, *Science et opinion. Histoire d'un divorce*, Paris, Seuil, 2003.
[25] Newman, William R. "Technology and the Alchemical Debate in the Late Middle-Ages, *Isis* 80 (1989): 423–445.
Newman, William, and Larry Principe, *Alchemy tried in the Fire*, Chicago, University of Chicago Press, 2003.
Newman, William R. *Promethean Ambitions. Alchemy and the Art-Nature Debate*, Chicago, Chicago University Press, 2004.

soon developed experimental tests (such as cupellation and cementation) to guarantee the authenticity of their gold and they also invented experimental demonstration: in order to convince their critics that the product of their art did not differ from the naturally occurring kind of metal they used to decompose and then recombine their metallic compounds. Later on when the art/nature objection had been superseded and replaced by an academic culture more favorable to arts, eighteenth-century natural philosophers who sought to promote chemistry invented the demarcation between alchemy and chemistry in order to dignify their science.[26] The face of chemistry – both its methods and its status – has been deeply influenced by the public attitudes towards its achievements. Symmetrically Western culture has been deeply transformed by the alchemists' enthusiastic support for making artificial substitutes for natural products.

Chemistry is no exception. The interaction between the role assigned to the public and the advancement of science could also be studied in other cases. Experimental physics, for instance, grew up as part of the culture of curiosity as much as a branch of academic culture. In the eighteenth century it developed through spectacular experiments – optical magic chambers, Leyden jars, and all sorts of automata – in aristocratic salons, shops and fairs. Nevertheless itinerant lecturers who performed spectacular or recreational experiments were gradually discredited and condemned as illegitimate practitioners. [27]

Conclusion

This paper confirms the various doubts expressed in this Focus about the legitimacy of the category of popularization for historical studies. Popular science is a transient and contingent notion characteristic of nineteenth and twentieth century science when scientific practices came to be gradually confined into academic space, thus configuring the "public" as passive spectators or users of their products. This notion cannot be extrapolated either to earlier period of time (when amateur practices of science were legitimate) or to more recent history (when technoscience is open to the market and permeates our daily life). The recent "paradigm shift" in the relation between science

[26] Lawrence Principe ed. *Chymists and Chymistry. Studies in the History of Alchemy and Early Modern Chemistry*. Philadelphia, Chemical Heritage Foundation, 2007.
[27] On the culture of curiosities see K. Pomian., *Collectionneurs, amateurs et curieux. Paris-Venise: XVIe-XVIIIe siècle*, Paris , Gallimard, 1987.P. Smith, P. Findlen eds, *Merchants and Marvels: Commerce, Science and Art in Early Modern Europe*, New-York, Routledge, 2002. On Enlightenment science: W.Clark, Jan Golinski J., and Simon Schaffer eds, *The Sciences in Enlightened Europe*, Chicago, University of Chicago Press, 1999; Larry Stewar., *The Rise of Public Science*, Cambridge: Cambridge University Press, 1992 ; B. Bensaude-Vincent, Christine Blondel eds, *Science and Spectacle in the European Enlightenment,* Aldershot, Ashgate, 2008. On nineteenth-century, Aileen Fyfe and Bernard Lightman (eds.), *Science in the Marketplace: Nineteenth-Century Sites and Experiences,* Chicago, The University of Chicago Press, 2007.

and the public reminds us that science does not hold the monopoly of knowledge in a society. It is always competing with rival forms of knowledge. Whether they are labeled as opinions or superstitions or prejudices, these alternative forms of knowledge contribute to shaping the methodological rules of scientific activity. Taking into account that popular science is just one distinct configuration of the distribution of knowledge in society, I suggest that we include this historical category within a broader research agenda: how science, as a normative activity, continually defines itself with regard to its "others" and thus asserts its authority and prestige.

In drawing a demarcation between experts and non-experts, between legitimate knowledge producers and charlatans or the lay public, science shapes the society at large. Historians of science have so far mainly focused on the process of production of scientific knowledge. We know a lot about the social construction of knowledge but what do we know about the construction of society through the hegemonic status of scientific knowledge? In order to characterize the "regimes" of knowledge production in the past, we have to focus on the process of mutual construction of legitimate science and "popular knowledge". Once we acknowledge that their interaction is a working hypothesis suggested by the recent shift here described – from the deficit model toward the participatory model – we have to test the hypothesis against a number of local case studies before any general conclusion can be inferred. We still need more local studies attentive to the variety of cultures of science – from the most academic to the less orthodox – in any period of time. How did they interact? Did they learn from each other, ignore each other, or criticize each other? In particular, how, when, and in which circumstances was a clear boundary established between science producers and science transmitters (teachers, as well as popularizers)? On the peripheries, how did western science gain its authority and prestige by disqualifying indigenous science in colonial contexts? Concerning the critics of science, in the nineteenth-century – as Pandora rightly points out – the phrase "popular science" did not necessarily mean lower science. In some cases, popular science was promoted as an alternative science with strong criticisms of academic science. While anti-academism was as vigorous in science as it was in fine arts, it has been eclipsed and disqualified rather than celebrated by the posterity. There is no evidence that the strategies of discrimination and exclusion underlying the claims for scientific authority were the same over time and everywhere. It is therefore important to conduct comparative studies of various processes of discrimination among competing forms of knowledge. History of science in general will benefit from a better understanding of the "others" of science.